

Hydrological changes induced by the 2003 Tokachi-oki Earthquake, Japan

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(2) Geological Survey of Hokkaido

Akita and Matsumoto (2004), Sato et al. (2004)

The Tokachi-oki earthquake in 2003 (M 8.0, 26 September, 2003)



Missing peoples: 2

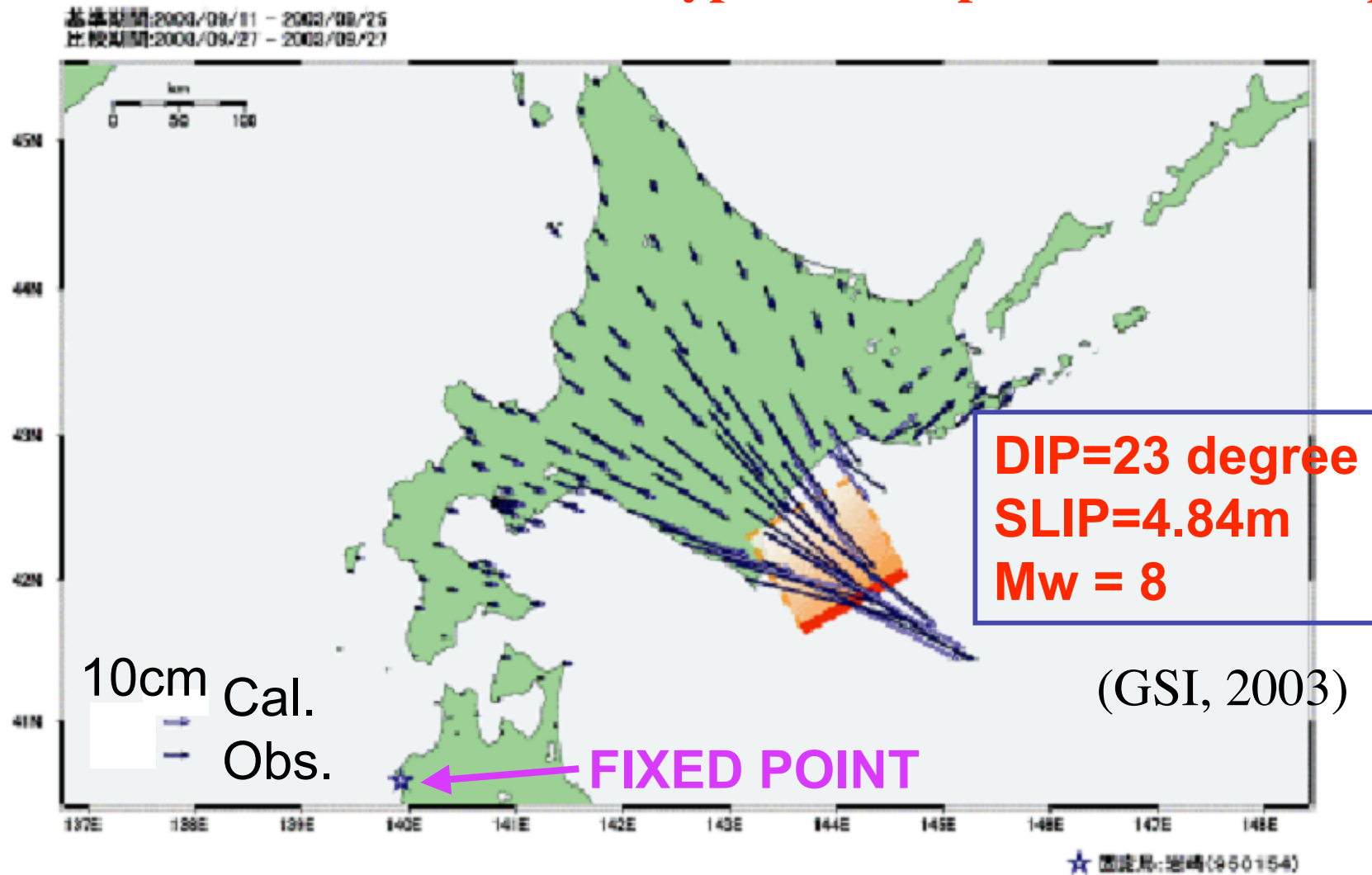
Injured peoples: 847

Damage: 27 billion yen

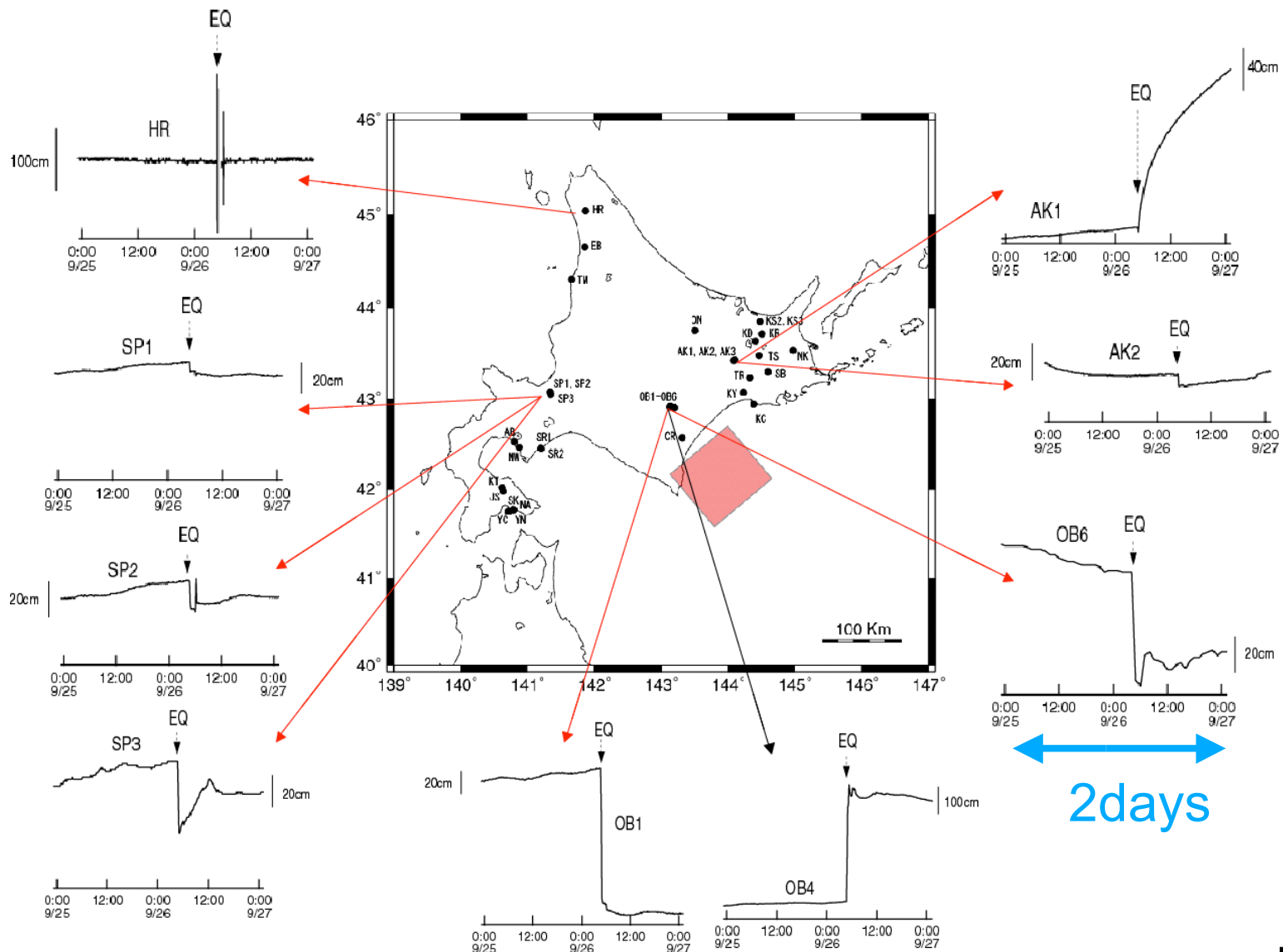
**No crustal deformation
(groundwater change)
related to the pre-slip.
If it existed,
the pre-slip <Mw 6**

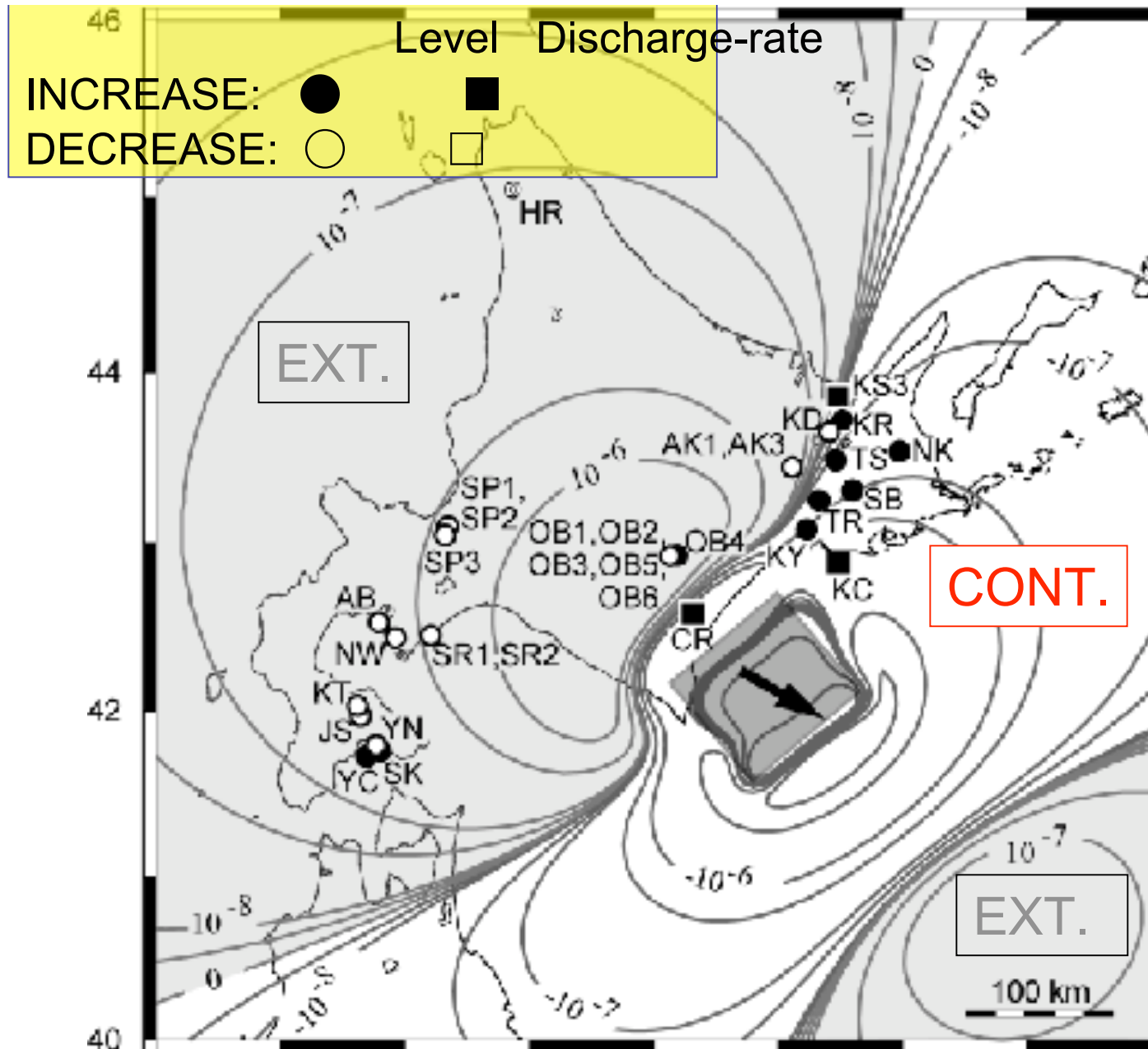
GPS OBSERVATION and THE ESTIMATED FAULT MODEL

Typical inter-plate thrust earthquake



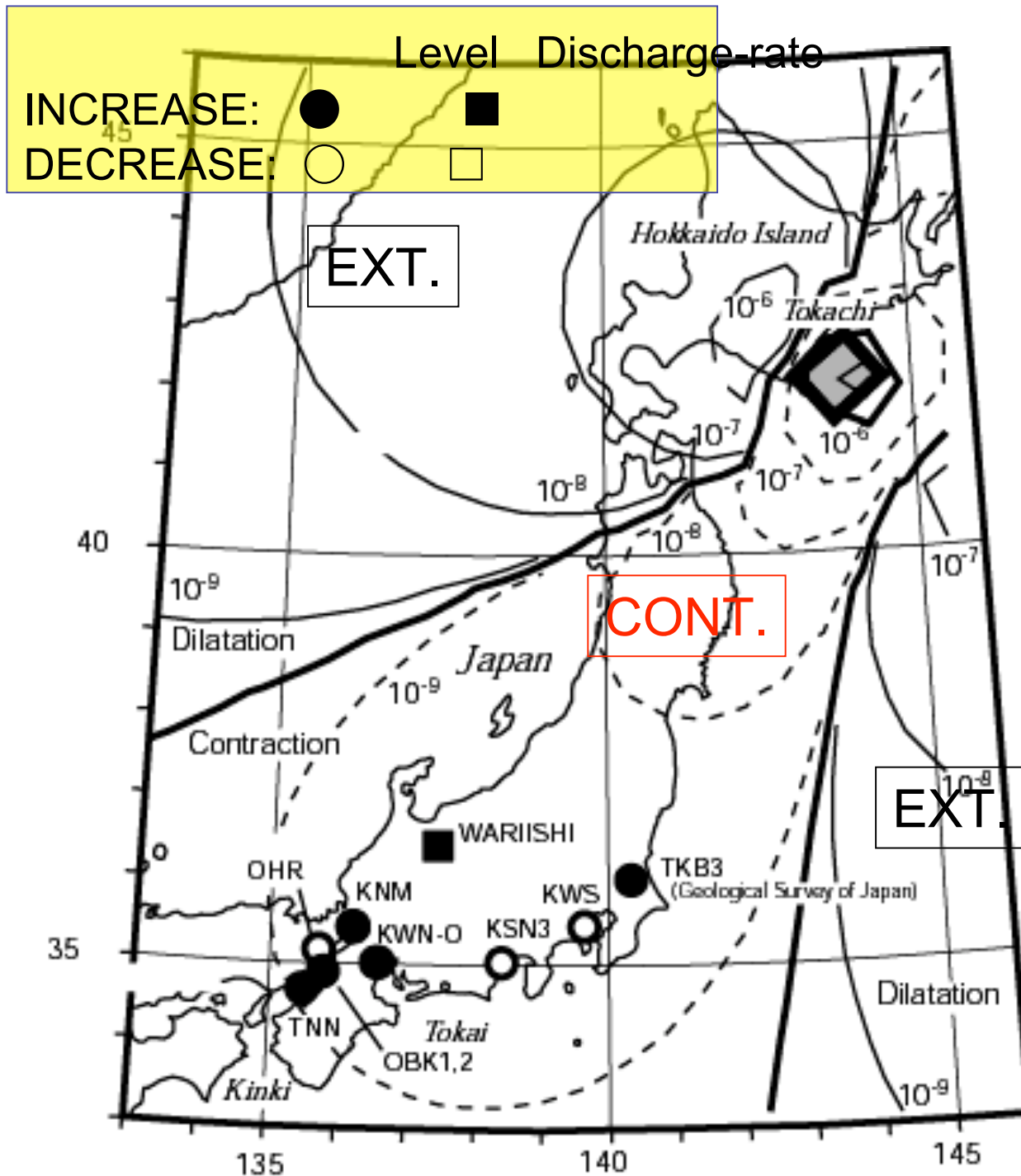
Observed groundwaters in Hokkaido: 32, confined.
Screened depths: 24-1488m, Most of them >100m





29 of the 32 coseismic changes can be explained by poro-elastic responses to the coseismic static volumetric strain changes.

INCREASES AND DECREASES IN THE COSEISMIC CHANGES

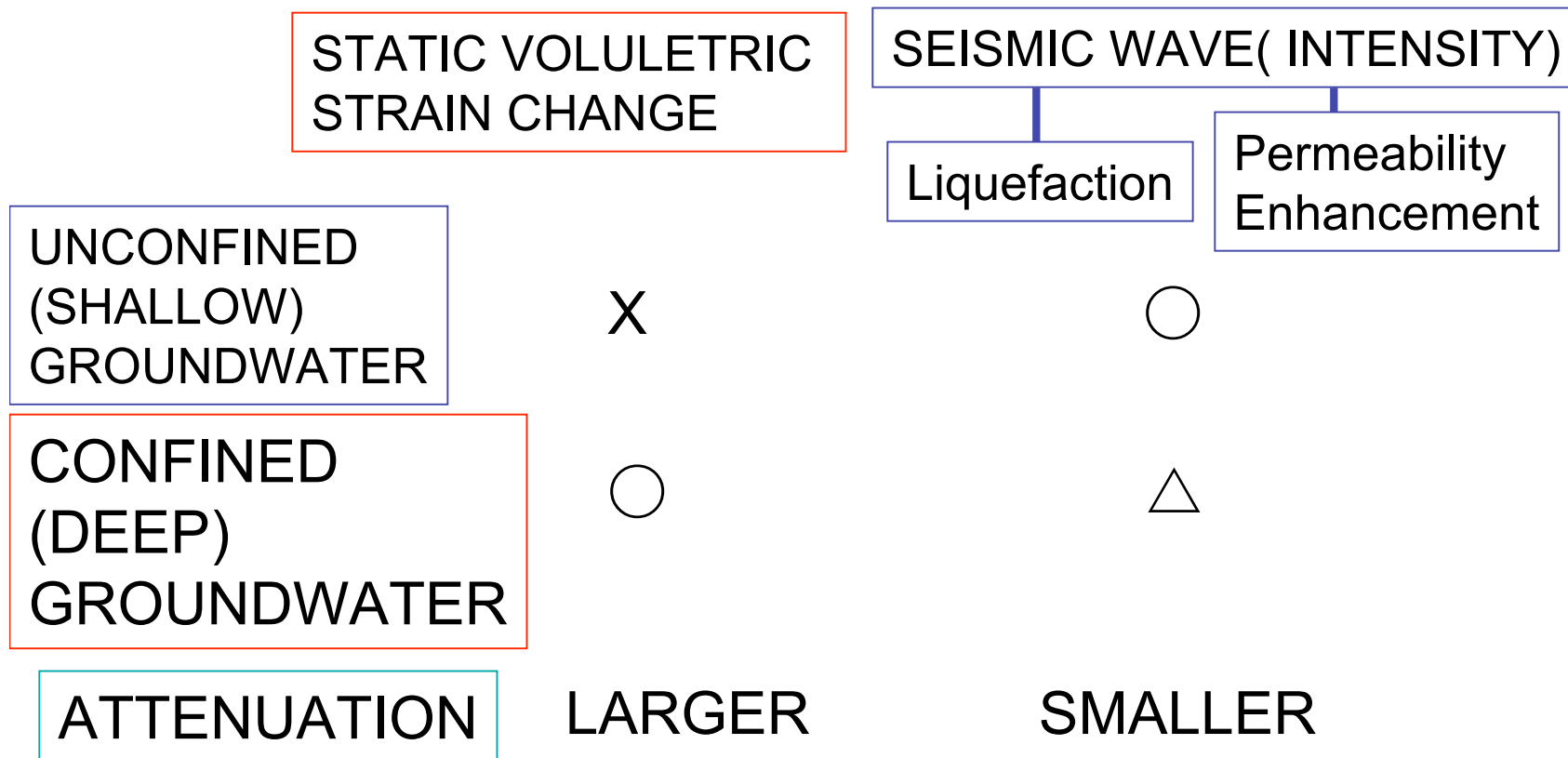


Coseismic changes were also detected at **10** of the **42** observation wells in Honshu.

7 well-water levels can be explained by the poro-elastic responses.

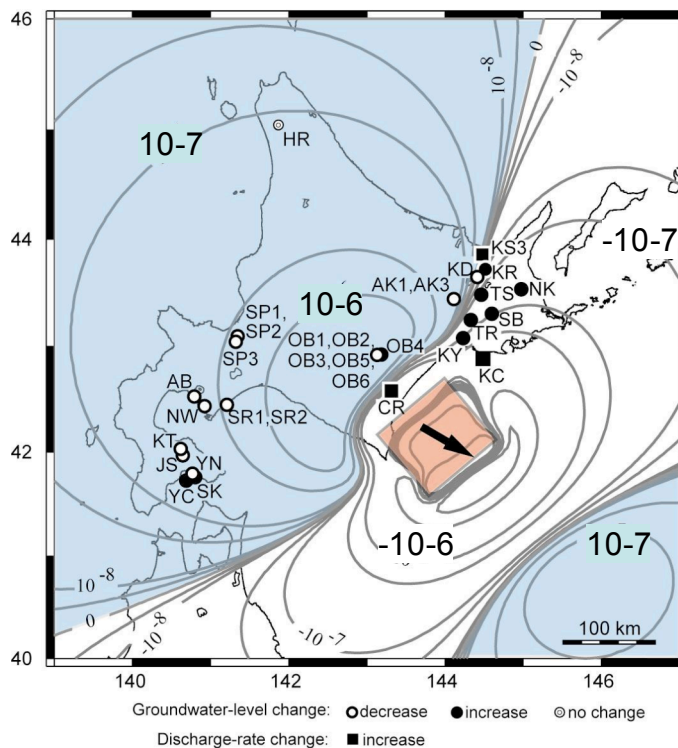
WHY IS THE COSEISMIC **CHANGES IN HOKKAIDO** EXPLAINED WELL BY STATIC VOLUMETRIC STRAIN CHANGES?

TWO MAIN FACTORS OF HYDROLOGICAL COSEISMIC CHANGES

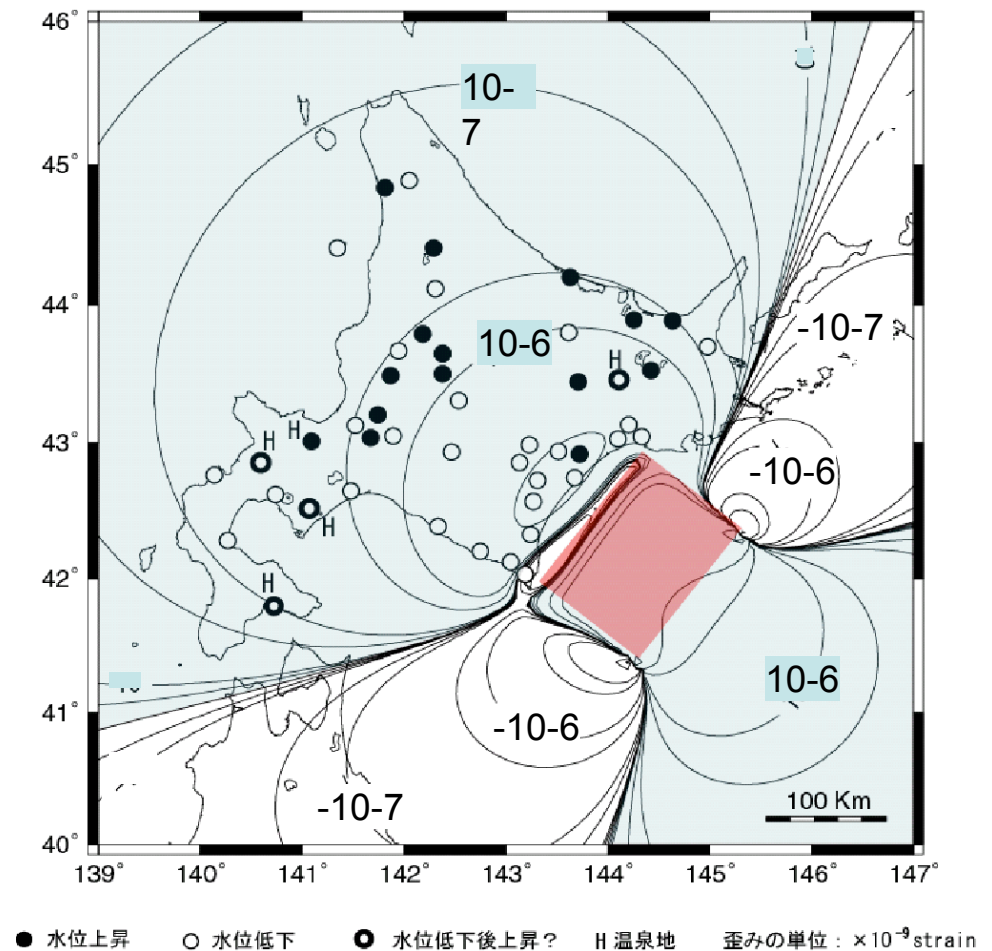


NEAR-FIELD DEEP and CONFINED GROUNDWATER IS SENSITIVE TO COSEISMIC VOLUMETRIC STRAIN CHANGE

Comparison of coseismic response to the **1952** Tokachi-oki earthquake with that to the **2003** Tokachi-oki earthquake.



2003 M8.0



1952 M8.2

FOR CHECKING THE AMPLITUDES IN COSEISMIC CHANGES

OBSERVED **TIDAL**
GROUNDWATER
LEVEL CHANGE

THEORETICAL
TIDAL STRAIN
CHANGE

STRAIN SENSITIVITY
OF THE GROUNDWATER
LEVEL

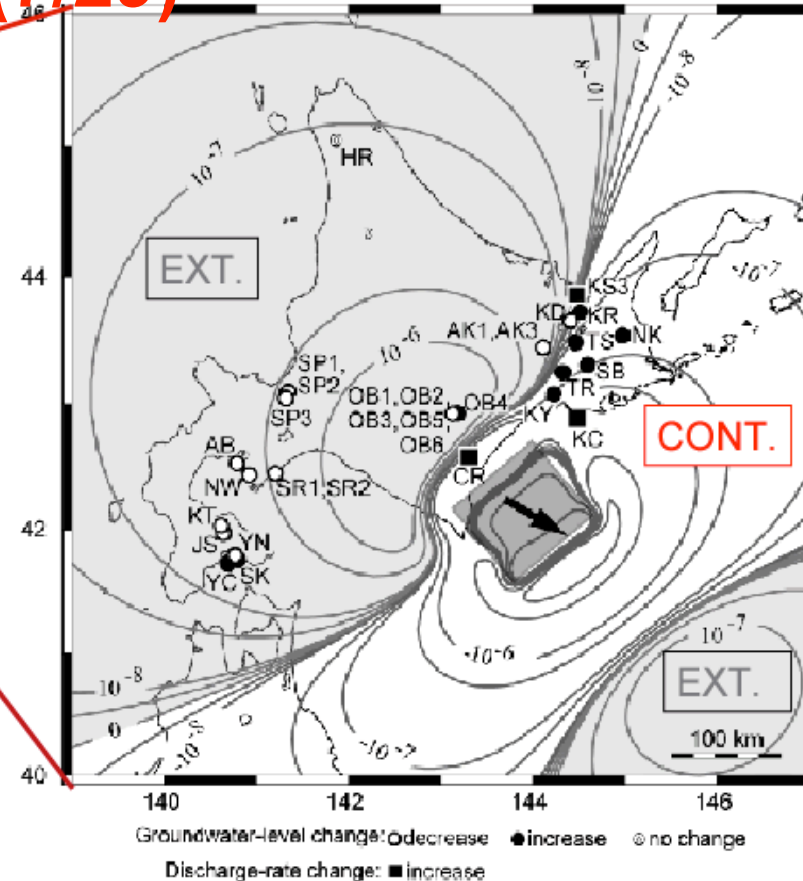
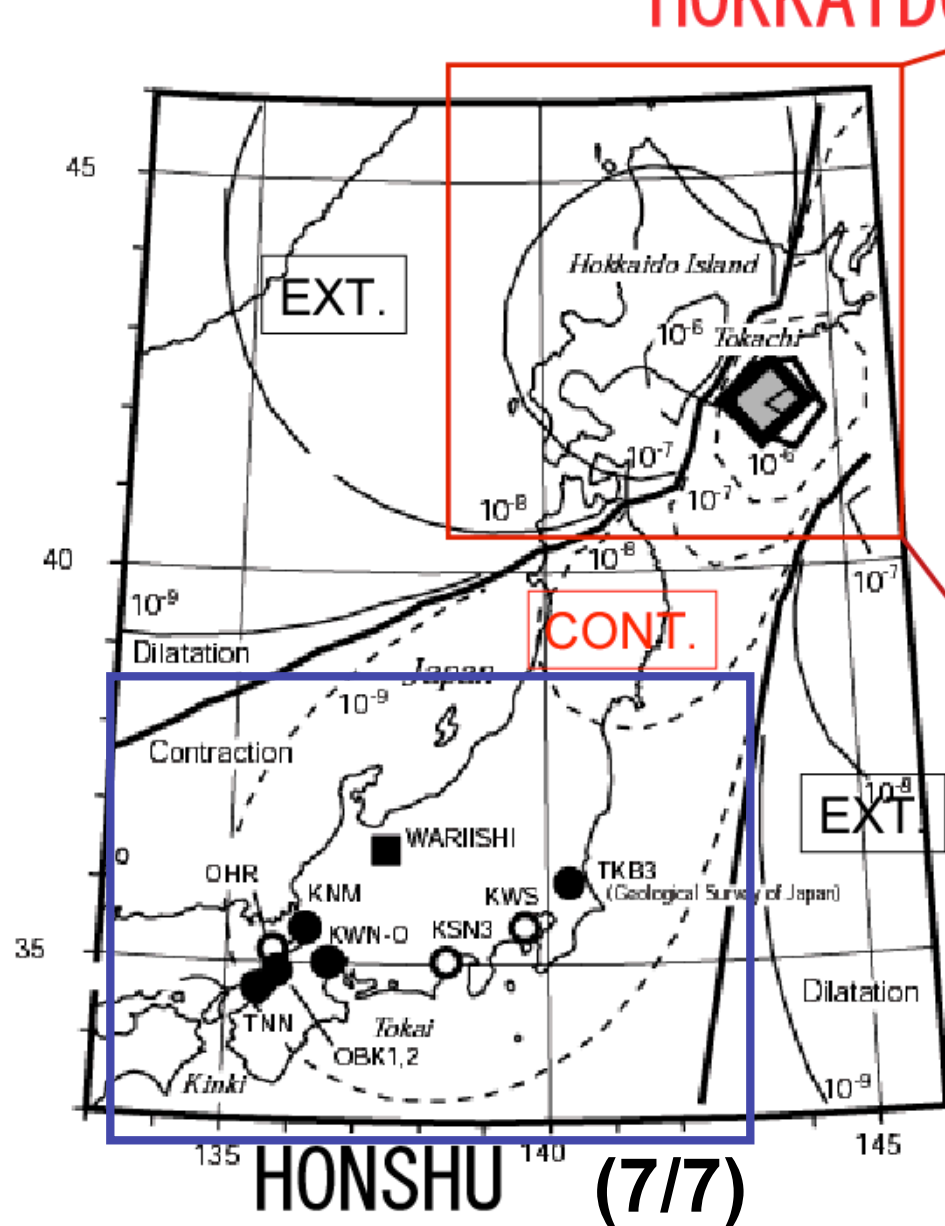
THEORETICAL **COSEISMIC**
STRAIN CHANGE FROM THE
FAULT MODEL

PREDICTED COSEISMIC
GROUNDWATER
LEVEL CHANGE BASED
ON PORO-ELASTIC
THEORY

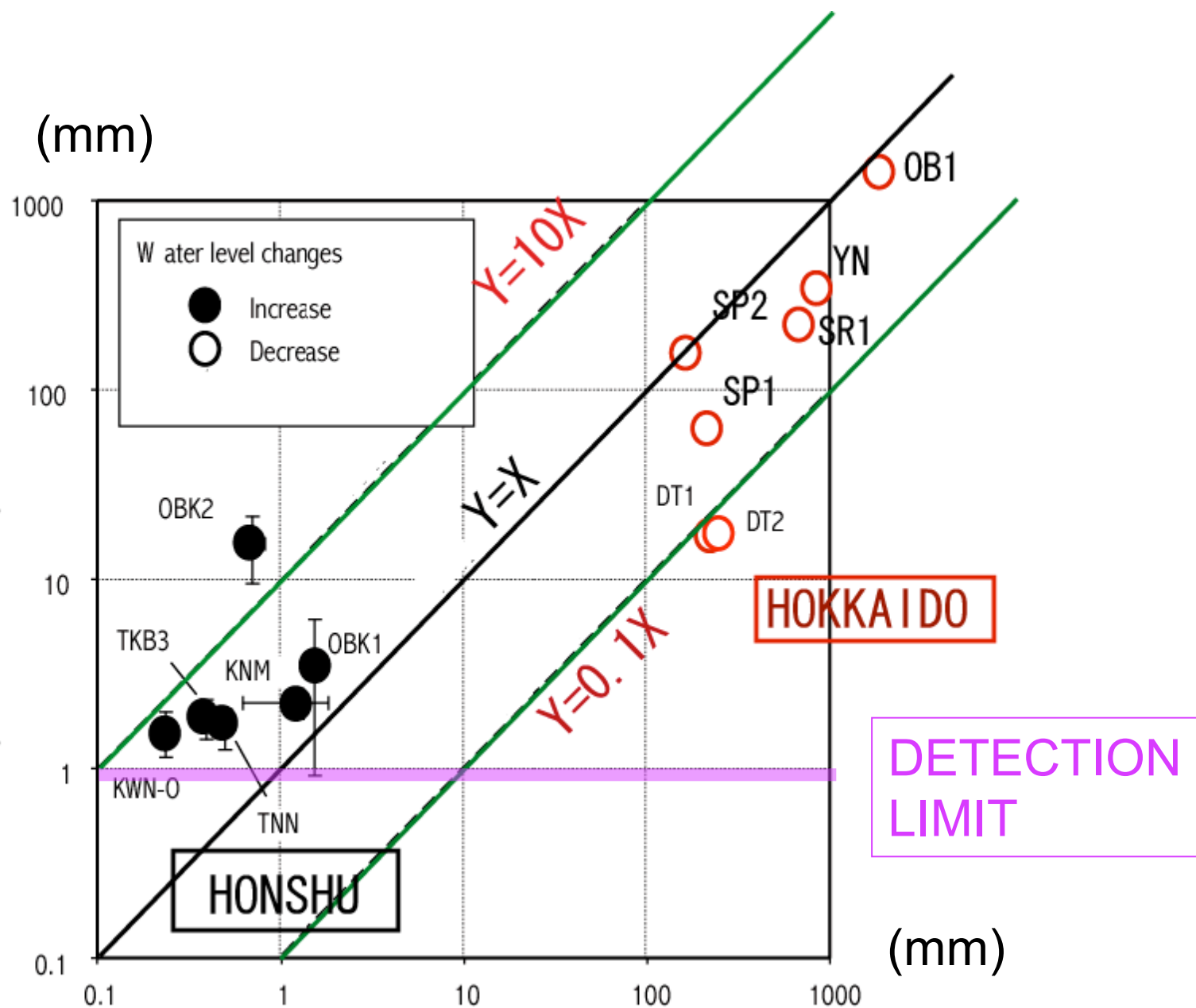
COMPARISON

OBSERVED
COSEISMIC
GROUNDWATER
LEVEL CHANGE

HOKKAIDO (7/29)

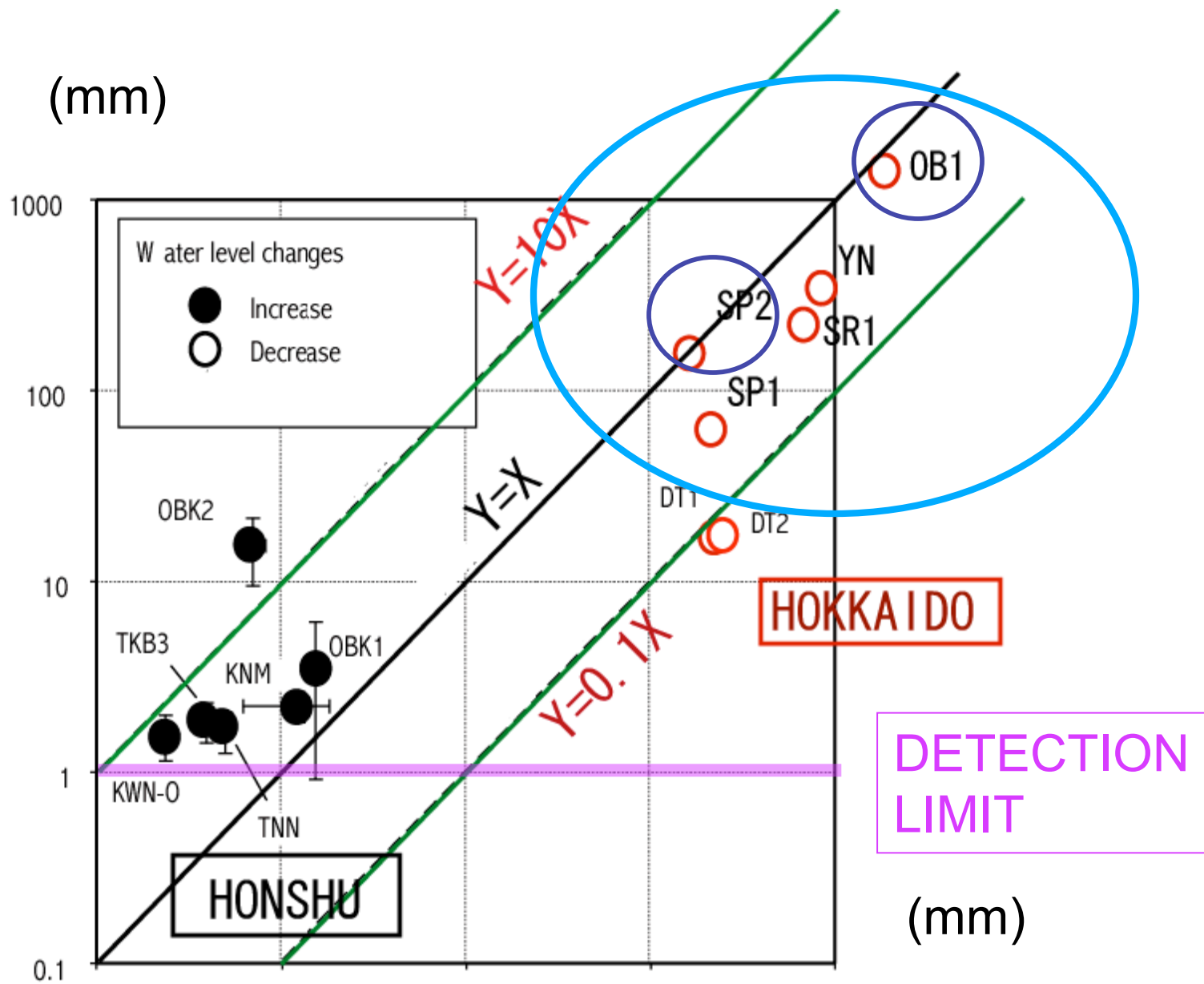


Y: OBSERVED COSEISMIC GROUNDWATER LEVEL CHANGE



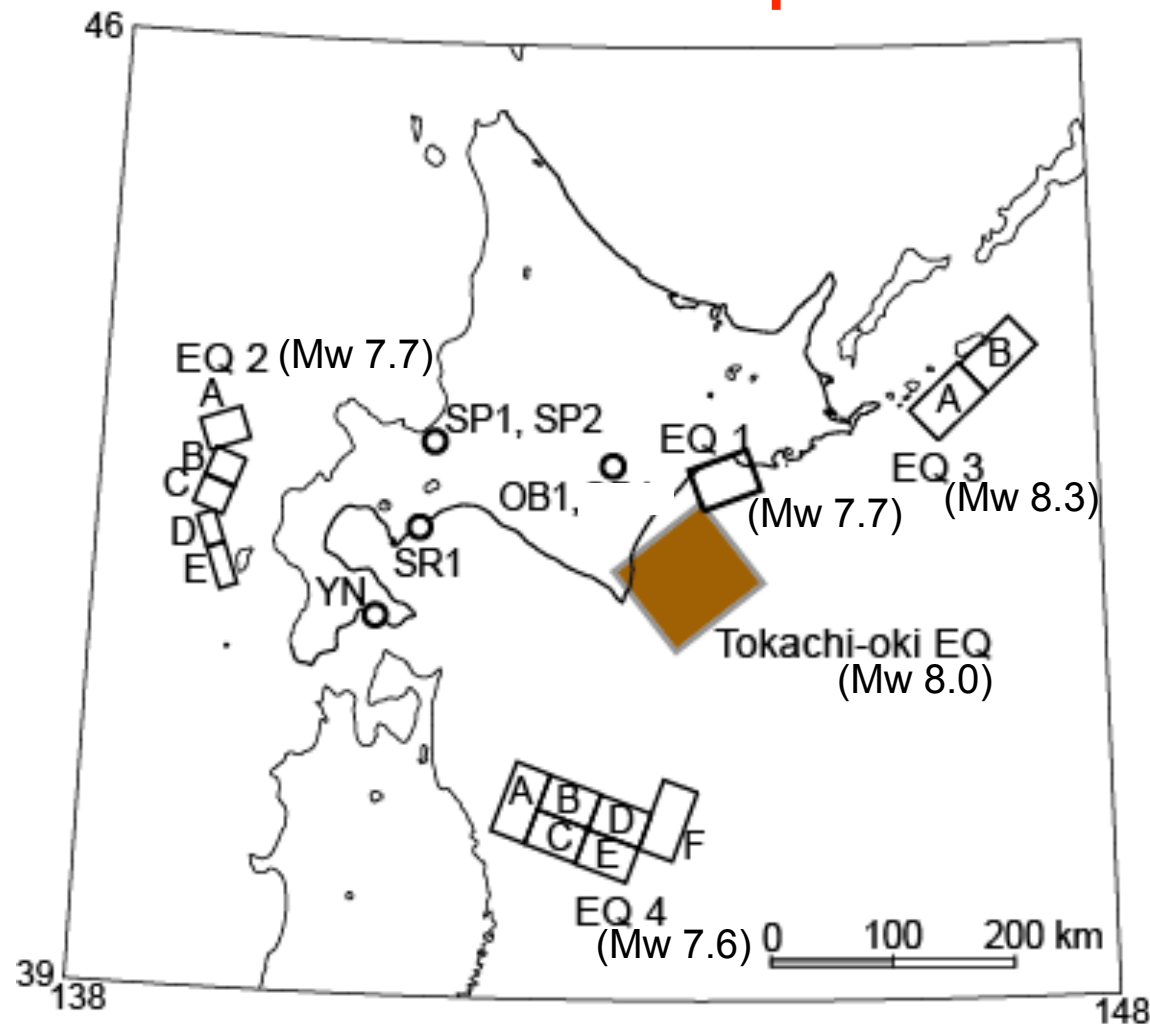
X: PREDICTED COSEISMIC GROUNDWATER LEVEL CHANGE

Y: OBSERVED COSEISMIC GROUNDWATER LEVEL CHANGE

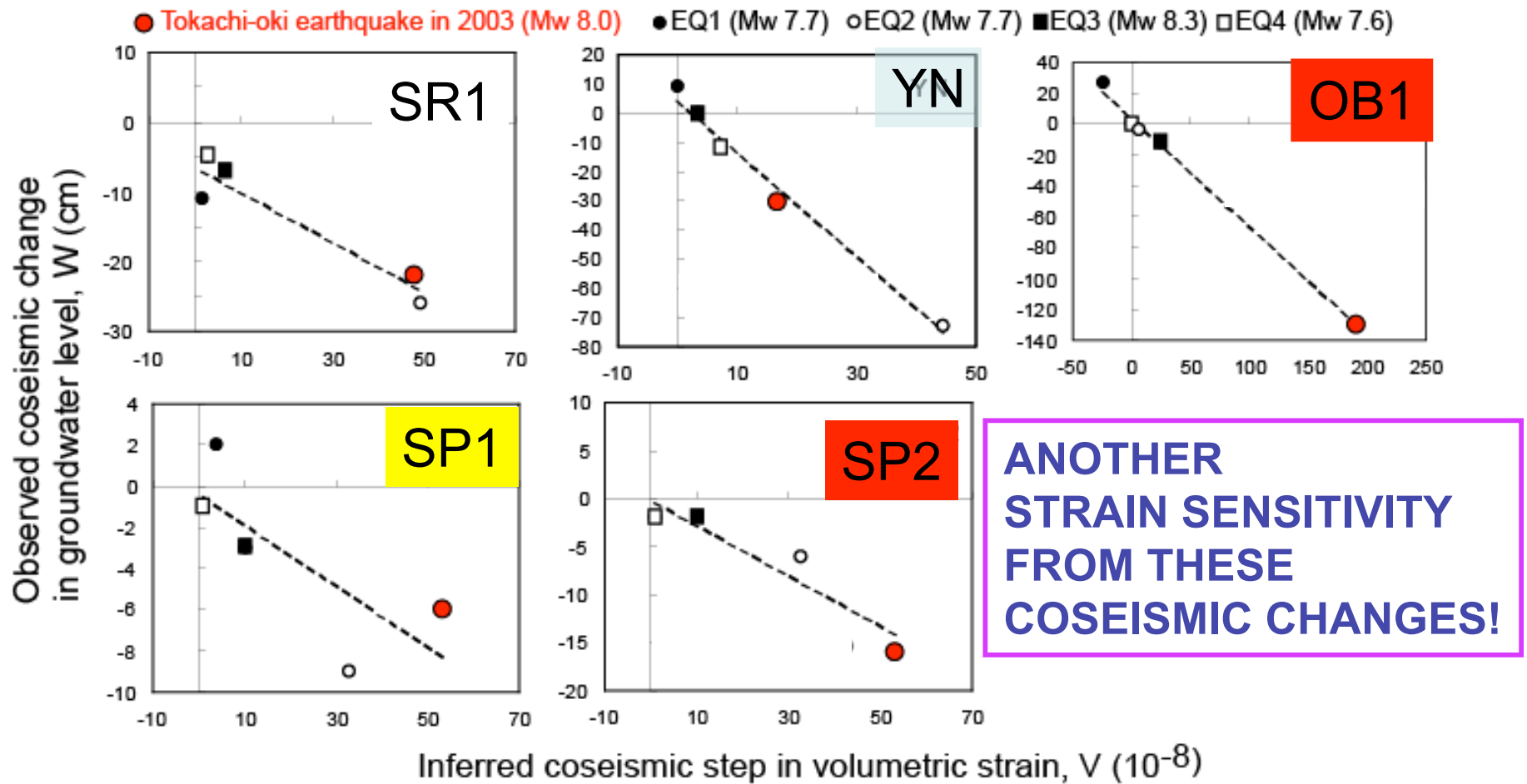


X: PREDICTED COSEISMIC GROUNDWATER LEVEL CHANGE ; **T**

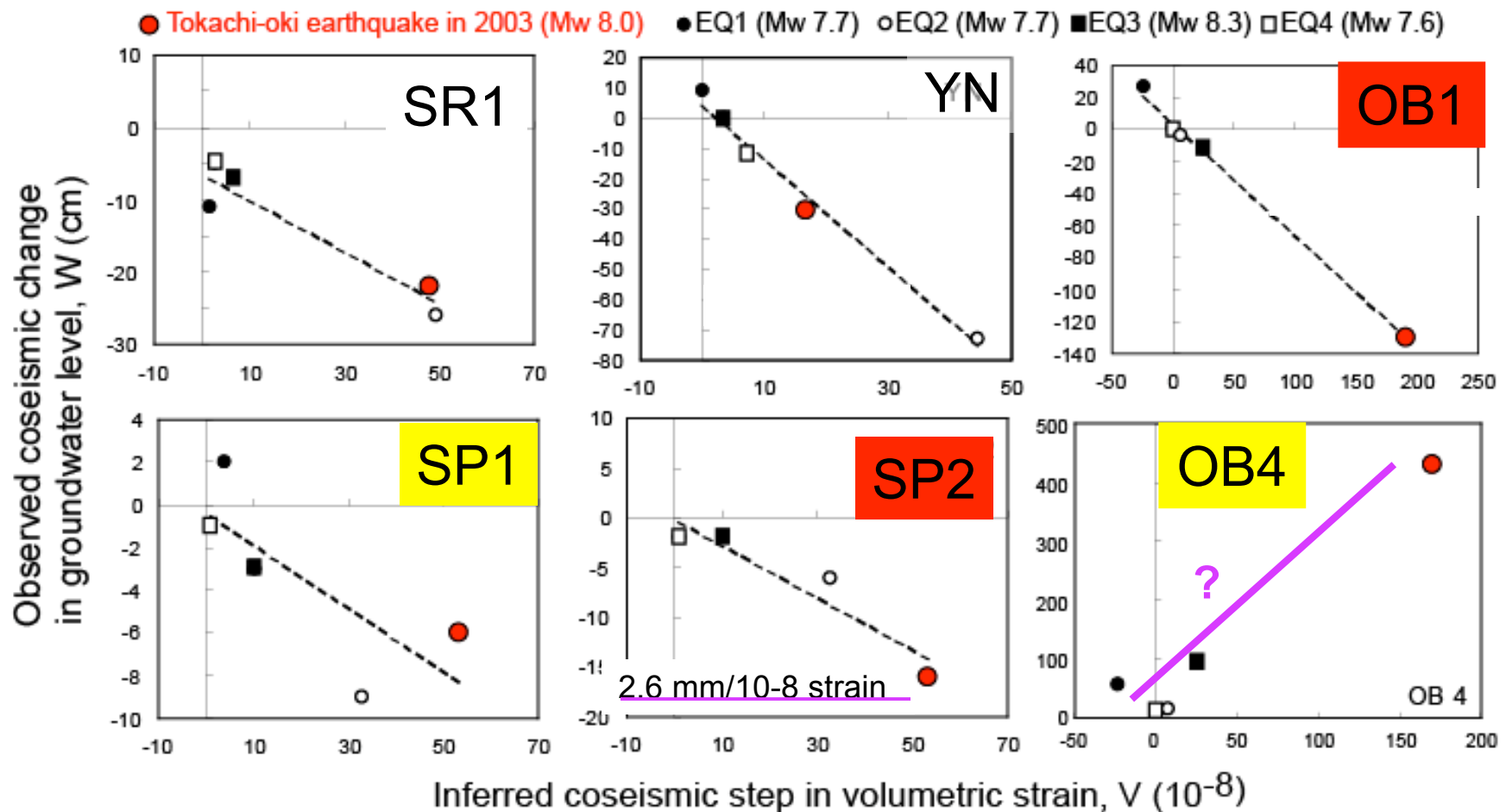
Four Large Earthquakes ($M_w > 7.5$) in 1993 –1994 and the 2003 Tokachi-oki Earthquake



Coseismic strain steps vs groundwater level changes in the 5 wells after the 5 large earthquakes



Coseismic strain steps vs groundwater level changes in the 5 wells after the 5 large earthquakes



Observation wells in OB and SP

(Coseismic changes related to the 2003 Tokachi-oki Earthquake)

well name	Screened Depth (m)	gwl change(cm)	strain (10-8)
OB1	950-1060	-130	191.4
OB4	1235-1400	430	170.3

well name	Screened Depth (m)	gwl change	Strain (10-8)
SP1	288-310 354-376	-6	53.2
SP2	539-594	-16	53.2

All observation wells in OB



well name	Screened Depth (m)	gwl	
		change(cm)	strain (10-8)
OB6	165-193	-65	190.3
OB5	560-670	-170	189.8
OB1	950-1060	-130	191.4
OB4	1235-1400	430	170.3
OB3	1258-1478	-100	169.6
OB2	1286-1506	-130	172.4

CONCLUSIONS

IN HOKKAIDO AREA, **HYDROLOGICAL COSEISMIC CHANGES** RELATED TO THE 2003 TOKACHI-OKI EARTHQUAKE WERE **WELL EXPLAINED BY COSEISMIC STATIC VOLUMETRIC STRAIN CHANGES AND PORO-ELASTIC THEORY**. IT IS PROBABLY BECAUSE **THEY ARE NEAR-FIELD DEEP CONFINED** GROUNDWATER RESPONSES TO THE EARTHQUAKE.

SOME WELL-WATERS SHOW SIMPLE PORO-ELASTIC RESPONSES. BUT THE **REASON OR CONDITION** FOR IT **IS NOT CLEAR**.